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REVISION OF THE CHILLICOTHE TEST-CORE SECTION

J. ERNEST CARMAN

Department of Geology, The Ohio State University, Columbus 10

This paper presents a correction in the interpretation of the section of the Chillicothe test-core as given by the present writer in an article published in this Journal (Carman, 1947). The core came from a well 3 miles southwest of Chillicothe on the Hirsh fruit farm. The well was drilled by the Engineering Experiment Station, The Ohio State University, to obtain a core for the determination of the petroleum content of the Ohio shale, foot by foot (Kerr, 1948). The entire core was studied by the writer for the determination of the rock units passed through, and discussed in the 1947 paper. The list of rock units penetrated was given in that paper as follows:

Rock Unit	*Thickness*			*Depth to Base*		
	Ft.		*In.*	*Ft.*		*In.*
Mantle rock	6	—	6	6	—	6
Sunbury shale	1	—	0	7	—	6
Berea sandstone	25	—	6	33	—	0
Bedford shale	91	—	0	124	—	0
Ohio shale	376	—	6	500	—	6
Olentangy shale	64	—	0	564	—	6
Niagaran dolomite	12	—	6	577	—	0

The present paper deals only with the basal unit of the above section, 12 ft. 6 in. thick which in the earlier paper was assigned to the Niagaran dolomite and described as follows (Carman, 1947, p. 53). "The dolomite is bluish-gray to brownish-gray and quite variable in texture. In part it is firmly crystalline and compact; in part of very rough texture with open spaces containing petroliferous staining; at places apparently brecciated as if crushed reef material; the basal 4 feet is largely oolitic dolomite. No identifiable fossils were found in the dolomite but in the porous, crushed reef-rock material there are structures that suggest the compound coral *Favosites* and concentrically laminated masses suggesting stromatoporoids, all greatly altered. Although not absolutely conclusive, the evidence indicates that this dolomite is upper Niagaran." This correlation agreed with the fact that in Highland and Adams counties to the southwest, the Ohio shale rests disconformably on a surface of Niagaran and Greenfield dolomites.

In the spring of 1953, in the studies of another geologist on detrital materials at the disconformable contact at the base of the Upper Devonian shale, the piece of the Chillicothe test-core containing the top of the dolomite was sectioned vertically. This section revealed a fossil entirely against the Niagaran age of the dolomite and led to a very thorough restudy of this lower part of the core with sections and polished surfaces at a number of horizons.

The Olentangy shale overlying the calcareous strata is dominantly blue-gray in color, but with many thin layers of brownish-black shale. The lowest 3 ft. is black and brownish-black shale with a few thin layers of blue-gray shale. The restudy of the 12 ft. of calcareous strata next below resulted in the following described section which is also shown graphically in figure 1.

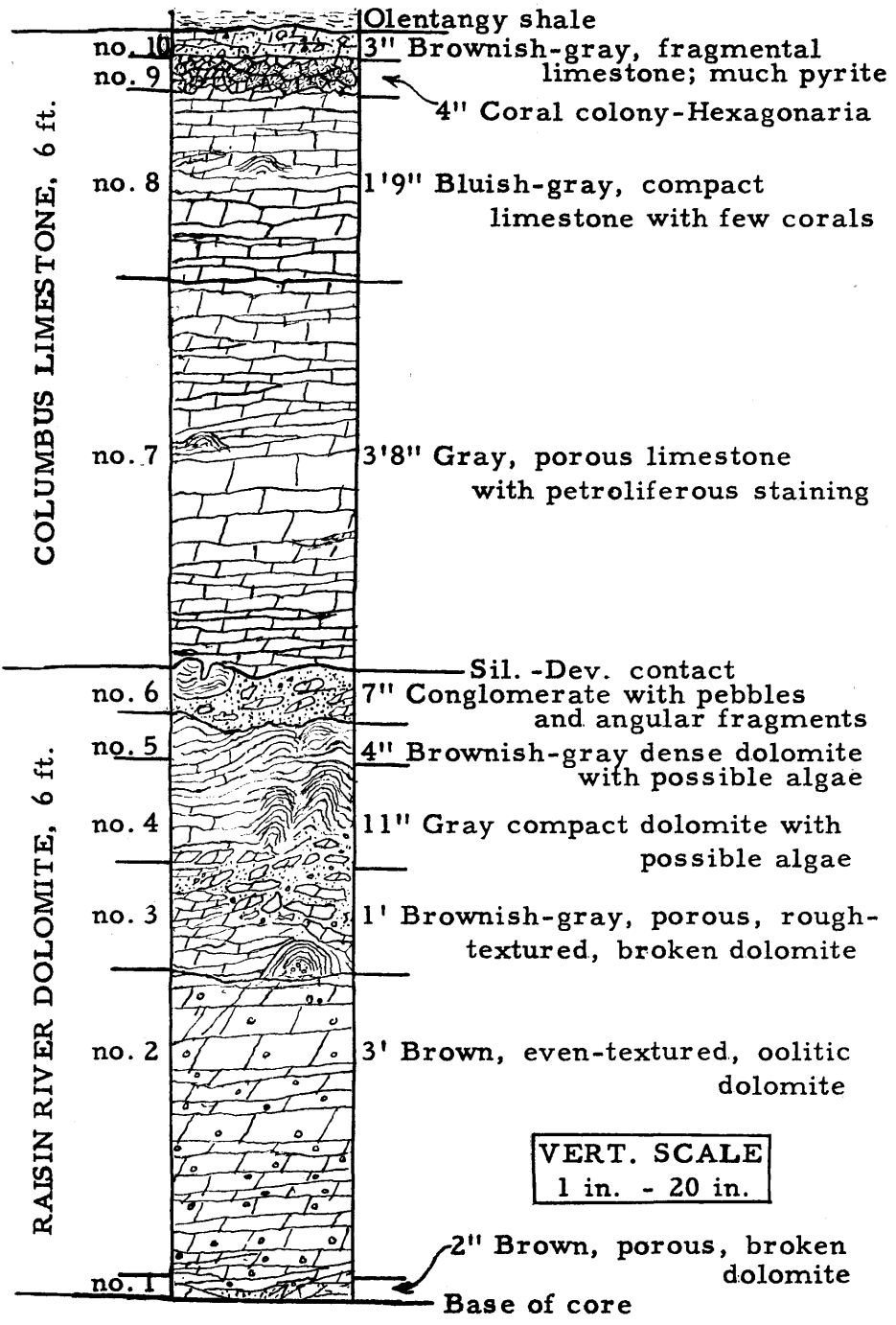


FIGURE 1. Columnar section of calcareous strata below upper Devonian shale

SECTION OF THE CALCAREOUS ROCK STRATA PENETRATED BY THE CHILLICOTHE TEST-CORE BELOW THE UPPER DEVONIAN SHALE

The zones are numbered from the base upward but discussed from above downward.

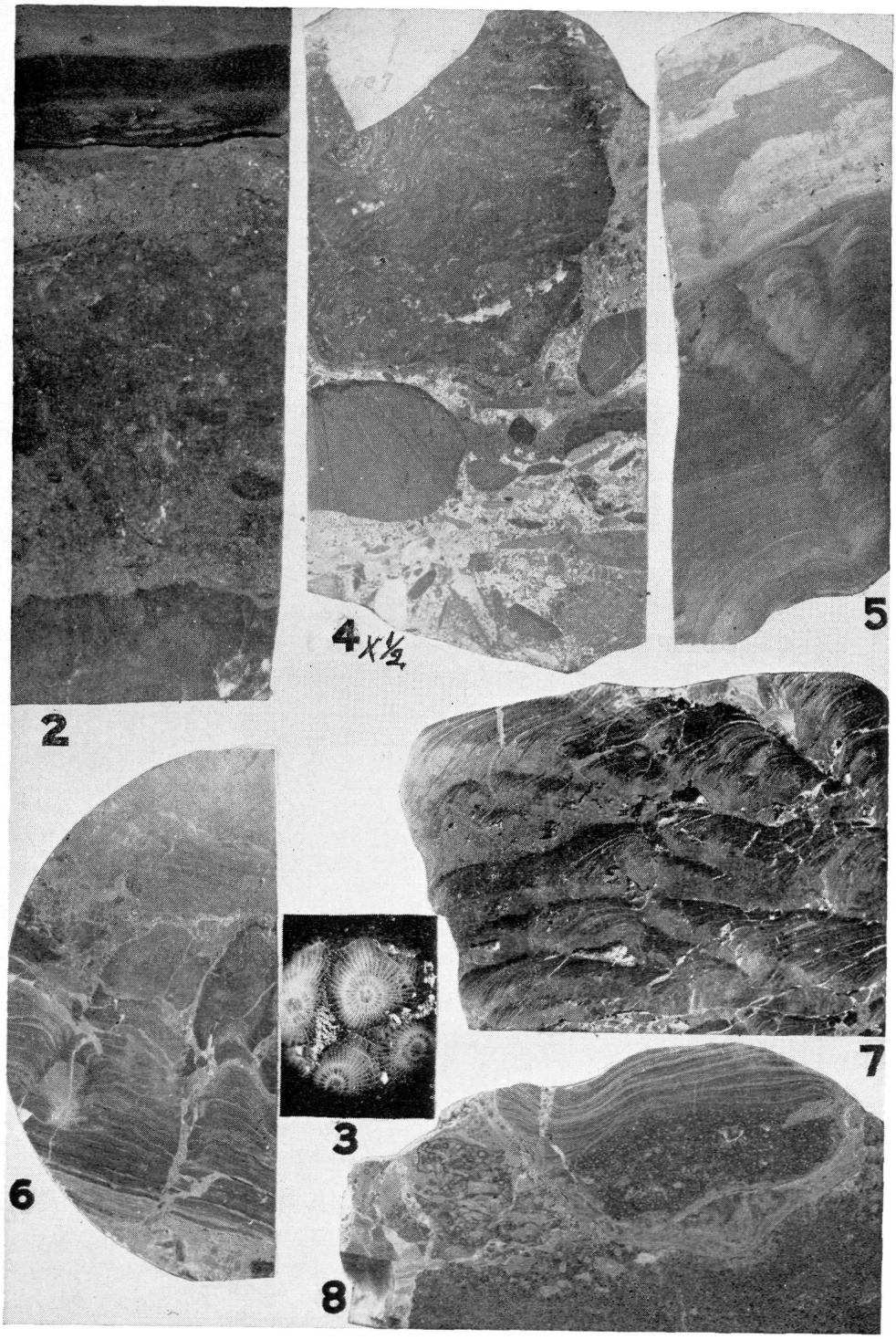
		Thickness Ft.	In.
10.	Gray to brownish-gray, compact, fragmental limestone with much pyrite..... Composed of small calcareous fragments firmly cemented in a matrix of finer grain. The polished section shows small coral tubes, a horn coral, and a compound Favosites-like coral, all pyritized, poorly preserved, and unidentifiable. There are small lenses of pyrite scattered through the mass and the upper ½ in. is dark in color and largely pyrite (fig. 2, middle part).	0	3
9.	Blue-gray, compact, limestone..... Composed entirely of part of a colony of the compound, compact coral *Hexagonaria prisma* (Lang and Smith) with the long corralities extending horizontally entirely across the core (fig. 2, basal part and fig. 3). Pyrite has been deposited in porous places and along cracks between or through the corallities. The contact with the unit above is sharp, with small jagged irregularities which cut across and into the internal structures of the corallites without any distortion. The basal contact of the dense coral mass, with the grainy limestone below, drops two inches in the width of the core and along this surface the limestone forms a sharp contact laterally or vertically with any part of the corallites. These contacts of the coral mass are interpreted as solution contacts. The horizontal position of the corallites and the nature of the contacts indicate that the coral colony must have been overturned, probably moved, and was lying on the surface when buried by the detrital material above. The coral is thus a part of the detrital zone but certainly originated in the limestone unit below.	0	4
8.	Bluish-gray, fine-grained, compact limestone with some blue streaking and mottling on polished surfaces..... Locally, slightly porous with petroliferous staining. In the upper part are poorly preserved, unidentifiable, tubular corals and compound Favosite-like corals.	1	9
7.	Gray to bluish-gray, porous, crystalline limestone with much petroliferous staining..... Favosite-like, coral structure can be recognized in several of the porous areas and probably most of the porous spaces have originated by the weathering of corals. The basal 9 in. is firmer and more finely crystalline.	3	8
6.	Dark-gray to brown conglomerate containing a large pebble or cobble, medium-sized pebbles, small slabby fragments, all dolomite and all set in a matrix of medium to small grains (fig. 1, no. 6, and fig. 4)..... A longitudinal, polished section of the entire 7 in. of this zone shows at the top a cobble of dark-brown, dense dolomite over 4 in. across and several pebbles, ½ in. to 1 in. across. The lower part of the zone is made up of sub-angular, lenticular, and slabby particles of the dark-brown and gray dolomite. Finally all of these are enclosed in a matrix consisting of medium to fine grains of dark-brown and gray dolmite, oolites, quartz sand grains and much pyrite. The polished surface of the large cobble shows undulating, more or less contorted, discontinuous, alternating bands or lenses of dark-brown dolomite and less distinct, grayish-brown dolomite. The dark-brown color dominates but the undulating pattern is brought out by the floculent streaks of graysh brown. It is one of the types of structure commonly referred to algae and is so regarded by the writer although no positive algal structures have been found. Between the bands, singly or as thin partings, or in pockets, are small round or oblong dolomite grains 0.2 to 0.3 mm. in diameter, some of which appear to have concentric or radiating structure or appear hollow, and apparently are oolites. Most interesting are the cases where a number of these oolite-like bodies occupy a pocket which must have been at one time a depression in the surface of the algal mass made by the thinning and downfolding of the laminae locally. Such pockets have been figured by authors under the name conceptacles and the oolite-like bodies interpreted as spore cases or some other type of reproductive body (Wieland, 1914). The matrix consists of small sub rounded grains of compact gray dolomite; quartz sand grains; oolites; and fine calcareous sediment and pyrite which form the cementing material. The oolites are most distinct at the basal contact of the zone where the cement has been partly removed allowing each oolite to show its distinct form, and the absence of any interlocking crystalline texture. The upper contact of this zone in the core is a sloping, solution contact with a parting about 1 mm. thick of greenish, argillaceous material with quartz sand grains and	0	7

		Thickness Ft.	In.
	much pyrite. The stone below the parting across most of the core is the brown algal cobble and on one side of the core a stylolite prong of the gray, fine-grained limestone of the zone above, ¼ in. across and ⅞ in. long, extends down into the dense, brown, algal dolomite of the cobble showing the extent to which interlayer solution has taken place (fig. 1, zone 6).		
5.	Gray to brownish-gray, dense dolomite. This zone (fig. 5) may be largely of algal origin but is of a different type from the algal mass of zone 6. The lowest one inch is made up of thin laminae which have a broad domal structure ½ in. to 1½ in. across. This grades upward into a part in which the units are ½ in. to ¾ in. across and the laminae are more strongly domed, and this grades back quite abruptly to essentially horizontal laminae. The laminae consist of very thin, at places discontinuous, gray partings alternating with thicker brown units about three times as thick as the gray partings, which indeed appear to be inserted in the denser, brown stone. The upper 1 to 2 in. is light-gray and dark-gray, dense dolomite in alternating, undulating layers ⅛ to ½ in. thick with uneven contacts.	0	4
4.	Light-gray to brownish-gray, compact dolomite. The core of this zone was sectioned for its full length. The upper 2 to 3 in. is an algal mass composed of brownish-gray, dense dolomite with some irregularly shaped open spaces (figs. 6 and 7). It consists of thicker brown laminae and thin gray partings similar to those in zone 5 above but the mode of growth is quite different. The domed units are quite distinct columns being about ½ in. across and 3 in. long, lying transverse to the vertical of the core. The doming of the laminae is more pronounced. At the base of this algal mass in the core is a ½ in. to 1 in. layer of breccia in which angular fragments of brown algal stone are enclosed in a gray matrix. Farther down through the zone the texture is somewhat irregular and the color mottled as if crushing had taken place, and at the base of the zone much of the width of the core is breccia.	0	11
3.	Brown and brownish-gray, vesicular and porous, irregular-textured, broken dolomite. This zone consists of angular fragments of dark-brown, dense dolomite in a matrix of smaller fragments of brown dolomite, oolites, and brownish-gray, finer material. It was apparently formed by the crushing of a vesicular rock, possibly an algal mass with openings. At the base of this zone is a smooth rounded, domed surface 2 by 2½ in. and rising ½ in. above the enclosing stone (fig. 8). A vertical section through this domed mass, plus broken laminae on the upper surface, shows fifteen pairs of the characteristic succession of brown, dense layer and brownish-gray parting. The entire ball-like mass is enclosed in oolites.	1	0
2.	Brown, even-textured, oolitic dolomite. The stone is composed almost entirely of small oolites about 0.5 mm. in diameter. They are dominantly round, a few are oblong. On a polished surface of the stone they are shown imbedded in a dense dark-brown matrix.	3	0
1.	Brown, irregularly-textured, porous dolomite. Rough-textured dolomite consisting of masses of brown, dense stone, some oolite grains and gray porous matrix. It is somewhat broken or crushed thus resembling the stone of zone 3. This is the base of the core at well-depth 577 ft.	0	2

EXPLANATION OF FIGURES 2-8

2. Upper part, is base of Olentangy shale. Middle part is zone 10, the detrital material on top of Columbus limestone. Basal part is top of coral colony, Hexagonaria.
3. Cross section of corallites of *Hexagonaria prisma* showing diagnostic characteristics. Zone 9, Columbus limestone.
4. (X½) The detrital material at Siluro-Devonian contact, zone 6 entire. The large cobble above may show algal structure.
5. Structure in Raisin River dolomite, zone 5, that may be of algal origin.
6. Structure in Raisin River dolomite, zone 4, that may be of algal origin.
7. Same specimen as in No. 6, sectioned at right angle.
8. Specimen from Raisin River dolomite, zone 3, showing laminated domal mass enclosed in oolitic and detrital material.

Sections and photographs by Richard Bowman.


2
4 X ½
5
7
3
6
8

GEOLOGIC AGE OF THE CALCAREOUS ROCK STRATA

The following is a geologic column of the rock units present along a north-south belt through central Ohio. To this the reader may refer for the stratigraphic position of the unit-names used in the following discussion.

Upper Devonian	Ohio Shale	
	Olentangy shale	
Erian	Prout limestone	—not known South of Erie Co.
	Plum Brook shale	
	Delaware limestone—not known south of Franklin Co.	
Ulsterian	Columbus limestone—not known south of Pickaway Co.	
	Detroit River dolomite—not known south of Sandusky Co.	
	Hillsboro sandstone—locally at Sil.-Dev. contact.	
Bass Islands	Raisin River dolomite	
	Put-in-Bay dolomite	
	Tymochtee shaly dolomite	
	Greenfield dolomite	
Niagaran	Peebles dolomite	—in Highland and Adams Cos.
	Lilley dolomite	
	Bisher dolomite	

In the foregoing section of the calcareous strata below the Upper Devonian shale there are two detrital units; zone 10 and 9 at the top just below the shale where one might expect a stratigraphic break, and zone 6 near the center of the calcareous section where a stratigraphic break would be much less probable.

Zones 8 and 7 above the lower detrital zone consist of gray to bluish-gray, compact to somewhat porous, finely-crystalline dolomitic limestone. Very poorly preserved, unidentifiable corals, including slender tubular types, a small horn coral and compound Favosites-like forms exist in zones 7, 8, and 10. These corals suggest a Devonian age but the one decisive fossil of the entire calcareous section is the colony of the compound, compact coral *Hexagonaria prisma* (Lang and Smith) which forms zone 9 (fig. 1, no. 9; fig. 2, basal part; and fig. 3). The characteristics of the genus are very definite and our specimen is notably well preserved showing on polished sections all the essential internal structures. The genus *Hexagonaria* is known only from the Devonian and *H. prisma* is a species present in the Columbus limestone of central Ohio.

On the basis of this *Hexagonaria prisma* colony, supported by the unidentifiable corals of zones 7 and 8, we must decide that the rock unit which lies disconformably below the Upper Devonian shale is the Columbus limestone down to the lower detrital zone. This includes zones 7 to 10 with a total thickness of 6 ft.

In the Columbus region of central Ohio *Hexagonaria prisma* is known only in zone H at the top of the Columbus limestone, which formation has there a total thickness of about 100 ft. Further, it is believed, on fossil evidence that this upper part of the Columbus continues northward to the Sandusky region but that the lower part of the Columbus of central Ohio is overlapped northward. The presence of *Hexagonaria prisma* in this core suggests that it is the highest part of the Columbus that is represented here. Since the Columbus is only 6 ft. thick in the core and the specimen of *Hexagonaria* is at the top, this interpretation would require that the Columbus sea did not reach this locality until late in Columbus time. It seems improbable that the marine Columbus limestone overlaps eastward away from the Cincinnati anticline. As noted above (zone 9) there is evidence that the Hexagonaria mass is part of the detrital unit resting on the Columbus and therefore may have originated at a higher stratigraphic level and a later time than the limestone layer on which it finally came to rest. However, it is very improbable that a piece of limestone released from its parent ledge in a region of

denudation could remain on or in the mantle rock during the time required for the lowering of the region some 50 to 75 ft. and then become buried beneath the sediments of a new cycle of deposition without complete disintegration or decomposition.

It is noted in the description of the geologic section that the matrix of the lower detrital zone (no. 6) contains quartz grains. In the basal 3 to 4 in. these quartz grains may constitute 10 to 15 percent of the whole, decreasing rapidly upward. When freed from the dolomite by treatment with acid most of the grains are clear rock-crystal quartz between 0.25 and 0.5 mm. diameter, well rounded and pitted or frosted with minute pits. Some of the grains show secondary enlargement by growth of hexagonal pointed ends and high-luster prism faces. The characteristics of these sand grains are identical with those found at the Siluro-Devonian systemic contact from north to south across Ohio; the Sylvania sandstone of Lucas County, the basal zone A of the Columbus limestone of central Ohio, and the Hillsboro sandstone of Highland County in southern Ohio. At all places, this sand or sandy material rests disconformably on the highest Silurian rock unit present at that locality when the sand was deposited. This is commonly on one of the four members of the Bass Islands group but in Highland County where the erosion had been greater, the Hillsboro sandstone at places rests on a still lower unit, the Niagaran dolomite. The sand unit is overlain by the first rock unit deposited at that place by the encroaching Devonian sea. In northern Ohio this is the Detroit River dolomite, the lowest Devonian rock unit in Ohio; in central Ohio the Detroit River is missing and the sand is found in the basal layers of the next overlying unit, the Columbus; and in southern Ohio where the Columbus and Delaware limestones are also absent the Upper Devonian shale rests on the sandstone or in its absence, on Niagaran dolomite.

On the basis of the characteristics of the quartz sand in this lower detrital zone and its stratigraphical position below the Columbus limestone in this part of Ohio, this zone 6 must mark the Siluro-Devonian contact horizon.

Zones 1 to 5 below the lower detrital unit consist of gray through brownish-gray to brown, compact to dense, and in part crushed or fractured dolomite. Oolites are present, and in zone 2 they constitute most of the rock material. No animal fossils were found in the 6 ft. of this lower division of the calcareous section but structures which are noted in the foregoing pages as probably fossil algae are present in zones 3, 4, 5, and 6. So far as the writer knows fossil algae have not been previously reported from any Silurian rock unit of Ohio and there are very few references to algae in Silurian or Devonian strata anywhere. Therefore these probable algae may have very little value for correlation purposes even when more thoroughly determined. The writer has long suspected that certain spheroidal and domal, laminated forms in the Bass Islands group might have had an algal origin but has found no conclusive evidence for this interpretation. One such rudely spherical, laminated form from the Greenfield dolomite of the Bass Islands was studied by John W. Wells with a negative conclusion as to having an algal origin (Wells, 1942).

The lithology of this lower unit accords well with that of the upper Bass Islands dolomite and especially with that of the Raisin River formation, the highest unit of the Bass Islands, and of the Silurian system in Ohio. The Raisin River is also suggested by the presence of oolitic dolomite so notably developed in zone 2 of the foregoing section and present also in zones 1, 3, and 6. Oolites are very characteristic of the Raisin River dolomite of Monroe County of southeastern Michigan, the type locality for this member (Grabau and Sherzer, 1910), and they have been seen at a few places in the Raisin River member in Lucas County, Ohio. There are many references in the literature noting the association of oolites and fossil algae in the same formation. Probably both require or are favored by a high percentage of calcium carbonate in the sea water whether they have an organic or a physico-chemical origin.

The Raisin River member has not been positively identified in central Ohio by its type fossils as known in southeastern Michigan and northwestern Ohio. However, the strata directly underlying the Columbus limestone in western Delaware and Franklin counties are certainly Upper Bass Islands (Put-in-Bay or Raisin River) and there, as in this Chillicothe test-core, the lithology indicated Raisin River rather than Put-in-Bay. In neither case does the lithology suggest the Greenfield or the Tymochtee, the two lowest members of the Bass Islands group.

On the bases of 1. stratigraphic position directly below the Columbus limestone; 2. the presence in the detrital zone 6 of the distinctive quartz sand that characterizes the Siluro-Devonian contact widely over Ohio; 3. the similarity of lithology; 4. the presence of oolitic dolomite; we assign zones 1 to 6 of the foregoing section to the Raisin River dolomite here penetrated only 6 ft.

The revision here presented does not effect the areal distribution of the rock formations concerned. There is therefore no change on the areal geologic map. It does however make somewhat more exact our knowledge of the actual distribution of certain formations under cover. Along a north to south course thru central Ohio the Upper Devonian shale (Olentangy and Ohio) overlaps the Prout and Plum Creek units south of Erie County so that in central Ohio the Olentangy rests on the Delaware limestone. Continuing southward it overlaps successively the Delaware and the Columbus and south of Pickaway County, rests on the Bass Islands or the Niagaran. The presence of 6 ft. of Columbus limestone in the test-core indicated that the north-south course of the west edge of the Devonian limestone under cover probably passes just west of Chillicothe.

South of Fayette County the Upper Bass Islands unit is not represented on the outcrop and the Lower Bass Islands unit has only a patchy distribution thence southward to beyond the Ohio River. On this basis it has been natural to assume that probably the Upper Bass Islands unit was never deposited in southern Ohio. The presence of strata here interpreted as Raisin River dolomite, the highest unit of the Bass Islands group, in the base of the test-core section, 18 mi. east of where the Greenfield passes beneath the upper Devonian shale, suggests that the complete section of the Bass Islands is present under cover to the east and southeast under southeastern Ohio.

LITERATURE CITED

Carman, J. E. 1947. Geologic section of the Chillicothe test-core. Ohio Jour. Sci. 47: 49–54.

Grabau, A. W. and **Sherzer, W. H.** 1910. The Monroe formation of Southern Michigan and adjoining regions. Mich. Geol. and Biol. Surv. Pub. 2: 35–37.

Kerr, T. H. 1948. Ohio State Univ. Studies, Engi. Exp. Sta., Bull. 133: 36–44.

Wells, J. W. 1942. Pseudo-algal nodules in the Greenfield dolomite. Ohio Jour. Sci. 42: 53–59.

Wieland, G. R. 1914. Am. Mus. Nat. Hist. Bull., 33: 241–244.